Safety in Segment Lifting Case of Narmada River

Kumar Ashish

Department of Chemical Engineering
National Institute of Technology Rourkela

Safety in Segment Lifting Case of Narmada River

Dissertation submitted in partial fulfillment

of the requirements of the degree of

Master of Technology

in

Safety Engineering

by

Kumar Ashish

(Roll Number: 214CH2552)

based on research carried out

under the supervision of

Prof. Rama Krishna Bag

May, 2016

Department of Chemical Engineering

National Institute of Technology Rourkela

Department of Chemical Engineering
National Institute of Technology Rourkela

May 23, 2016

Certificate of Examination

Roll Number: *214CH2552*
Name: *Kumar Ashish*
Title of Dissertation: *Safety in Segment Lifting Case of Narmada River*

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Rama Krishna Bag Principal Supervisor	Member, DSC
Member, DSC	Member, DSC
External Examiner	Chairperson, DSC

P. Rath
Head of the Department

Department of Chemical Engineering
National Institute of Technology Rourkela

Prof. Rama Krishna Bag
Assistant Professor

May 23, 2016

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This is to certify that the work presented in the dissertation entitled *Safety in Segment Lifting Case of Narmada River* submitted by *Kumar Ashish*, Roll Number 214CH2552, is a record of original research carried out by him under my supervision and guidance in partial fulfillment of the requirements of the degree of *Master of Technology* in *Safety Engineering* . Neither this dissertation nor any part of it has been submitted earlier for any degree or diploma to any institute or university in India or abroad.

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Rama Krishna Bag

Declaration of Originality

I, *Kumar Ashish*, Roll Number *214CH2552* hereby declare that this dissertation entitled *Safety in Segment Lifting Case of Narmada River* presents my original work carried out as a PostGraduate student of NIT Rourkela and, to the best of my knowledge, contains no material previously published or written by another person, nor any material presented by me for the award of any degree or diploma of NIT Rourkela or any other institution. Any contribution made to this research by others, with whom I have worked at NIT Rourkela or elsewhere, is explicitly acknowledged in the dissertation. Works of other authors cited in this dissertation have been duly acknowledged under the sections "Reference" or "Bibliography". I have also submitted my original research records to the scrutiny committee for evaluation of my dissertation.

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May 23, 2016
NIT Rourkela

Kumar Ashish

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- *Reflection*: My thesis I did in larsen and Tubro Ltd at gujarat 3rd narmada extra dosed bridge.It is one of the longest extra dosed bridge in India.My thesis totally focused on the stability of the barge and safe operation procedure while lifting.

- *Thanking*: I would like to thanks My co supervisor Rajesh Kumar Singh EHS Manager of the 3rd Narmada Extra Dosed bridge,Bharuch for his valuable guidance and support .This work would not have been possible without the help of all the research members for their support and good wishes. Finally, I am forever indebted to my parents and brother for their understanding, endless patience and encouragement from the beginning.

- *Announcement*: I,Kumar Ashish, Roll Number 214CH2552 hereby declare that this dissertation entitled Safety in Segment Lifting Case of Narmada River presents my original work carried out as a postgraduate student of NIT Rourkela and, to the best of my knowledge, contains no material previously published or written by another person, nor any material presented by me for the award of any degree or diploma of NIT Rourkela or any other institution..

May 16, 2016 *Kumar Ashish*
NIT Rourkela Roll Number: 214CH2552

Abstract

Shipment of the segments and its stability while loading and unloading of cargo over the barge.The calculation of meta center and Meta centric radius makes the barge stable .3.6 tonnes per centimeter immersion increase one centimeter height of the drought .The dimensions of the barge and its displacement of total volume of water helped for calculation of overall mass of the barge .The flooded tank water inertia affects the meta center height of the loaded segment and barge loss its stability. The height if the cargo and maximum in range between 30 degree to 40 degree affects the hull structure.Center of buoyancy force which act in middle of the vessel or ship in upward vertical direction and the center of gravity which also act on the center of the vessel in downward direction this allow any vessel to float on the surface of the water is called as Archimedes principal .Meta center radius which help ship to float on water surface with stability —

- Calculation of GZ curve to determine the stability of the barge at the working load and the safe working load chart.The meta center height of the loaded cargo on the ship.The flow rate and the wind intensity at 360 mm of rainfall in 24 hrs.
- To prevent from the hull damage and collapse from the pier during the lifting operations.The preparation of risk assessment and the safe working process.
- By using the hydraulic tool box software and GZ curve plotting to determine the stability of the barge.
- If the rainfall intensity is 360 mm in 24 hours having the wing intensity of 30 m/s.The flow rate of the water is 35000 cubic meter per second then the lifting process is full of hazards.
- When heeling angle is above the 30 degree then the both center of buoyancy and gravitational force shift to the port or to the star board .Then the vessel if load is shifted to port side then the both acting force will shift to the starboard and make the ship in the stable position. Flooding tank which is designed in the vessel make the ship in stable position and prevent to damage of hull. Load which is shifted on the vessel should be fixed some time it creates the twisting moment in ship and heeling angle reached to the point more than 30 degree and ship loss it stability

A ship or vessel state to be in stable phase when both centre of buoyancy force and gravitational force meet at the centre of the vessel and the heeling angle should be in range of 7 degree to 8 degree .When heeling angle is above the 30 degree then the both centre of buoyancy and gravitational force shift to the port or to the star board .Then the vessel if load is shifted to port side then the both acting force will shift to the starboard and make the ship in the stable position. Flooding tank which is designed in the vessel make the ship in stable position and prevent to damage of hull. Load which is shifted on the vessel should be fixed some time it creates the twisting moment in ship and heeling angle reached to the point more than 30 degree and ship loss it stable.

***Keywords*: *Centre of Buoyancy*; *Block Coefficient*; *Tonnes per Centimetre*; *Metacentre Height*; *Metacentric Radius* .**

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Chapter 1

Introduction

The purpose to of this is too providing the safe lifting operations by the strand jacks on the water surface by barge. It is compulsory to make the sequences of the operations and the evaluation of the risk and its frequency. Safe working methods sequences should be in the details with role and responsibilities of the personnel. The various parameters considered are as under[1].

- Role and responsibility of the personnel.
- Safe working procedure.
- Risk assessments and hazards evaluation.
- Execution of the lifting operations.
- Emergency response plan and Emergency response

But while lifting on the water surface it is necessary to prepare the details dynamic nature of the water surface and its modelling. Barge stability is one of the important factor for the safe lifting on the water surface.

1.1 Standard Procedure for The Safe Lifting Operations

It is important too follow the sequences while performing the heavy lifting on the water surface.

- Details preparation of the risk assessments and hazards evaluation.
- Proper communication setup.
- Trained signal man and rigger.
- Third party certification and fitness of the equipments.
- Safe working load calculations and implementations.
- Safe working statements and the sequences of the lifting operations.

- NDT or DT is compulsory for the macloy bar rods to spot the cracks in the rod and third party certification of fitness.
- Proper illuminations if the lifting operation performed in the night.
- Physical and visual inspection of the equipments before and after lifting.
- Approval and supervision of the lifting operations should be done by the competent persons.
- Cordoning the area of in and around the area.

This are some important parameters considered while in the lifting operation .Job hazards analysis and HAZOP study should be done in the details by the competent person [1]. Person responsible for lifting operation ensure that

- Availability of the resources at the lifting sites.
- Ensure authorized personnel is involved in the heavy lifting or not.
- Monitoring of the lifting procedure and lifting sequences.
- Method of the statements and key role and responsibilities of personnel involved in the lifting plan.
- Conduct tool box meeting before the lifting for proper communication between the line people and management people.
- The competence and skill mix of a team is correct.
- Try to ensure no hot work should be done at the heavy lifting area or near the strand cables.
- Judgment on the conditions for safe lifting operations from soffit.
- The crane operator ensures that operation of the equipments should be done according the manual provided by the manufacturing company for safe lifting and minimize the risk frequency and hazards.
- If in the case of the hydraulic lifting it is necessary to check the level of the hydraulic oil and its gauge pressure.
- Safe working load chart and emergency contact number displayed on the lifting operations area.

The lift operations are categorized on the scale of the risk frequency and the consequences of the lifting operations[2].

- Routine lift – A normal risk assessments analysis and the lift plan can be used in this. But if the load is more than 150 tonnes then it fall under the special parameter. If the strand cables or the slings are used in the lifting process then it is compulsory to the check the elongation of the strand cables or the slings .Maximum permissible elongation is by 5 percent of its total length and if its threads are damaged by the 2 percent then it is not safe lifting and immediate replacements of the cable should be done.

- Non routine lifting - simple lifting complex lifting.For complex lifting its is necessary is perform the HAZOP study and the JHA, SOP, HAZID, work permit, crane chain, elongation of links, deformation of links, cracks, excessive wear, excessive corrosion, twists, bird caging, excessive rust or corrosion, excessive wear or abrasion, no overlapping ropes, no oil leaks from motor, earthing, free access of the job should be done in the details by the competent personnel.

The operator of the lifting equipments has to follow some safety rules and regulation for the execution of the lifting operations.

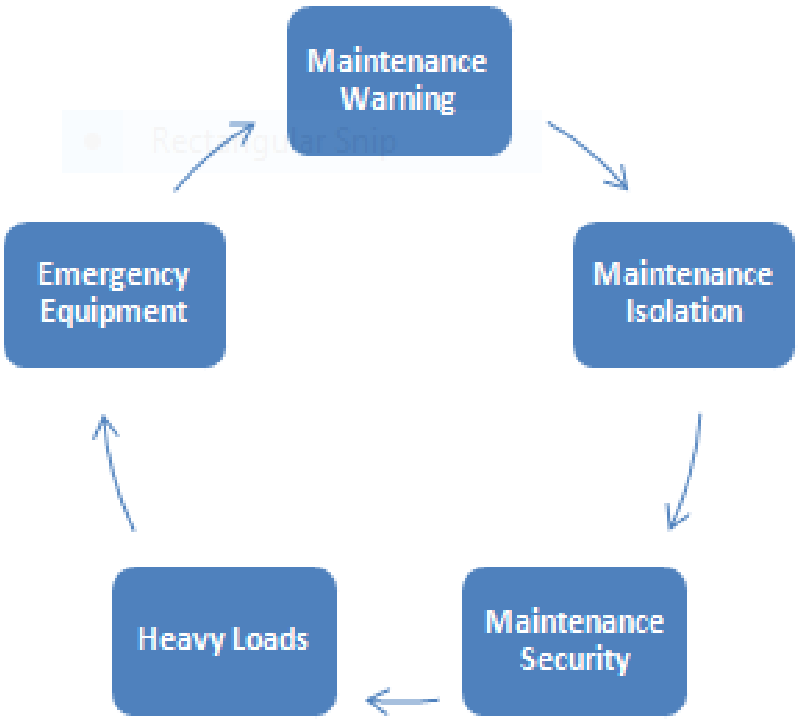

Figure 1.1: Safety Sequences While Lifting The loads.

Emergency response team and Emergency response plane always available at the lifting

site .In case of the heavy lifting where class one risk is involves so it is necessary to maintain the risk level or societal risk at level of ALARP. Assembly point and training of workmen are compulsory where heavy lifting operation is going on. Emergency sirens or air cutting siren installed near the lifting operations and mock drill should be done .After mock drill try to make analysis the response action of the workmen and engineers on duty. If there is lacuna in the quick response then training should be done by the competent person.

Chapter 2

Literature Review

2.1 Hydrostatic and Stability

Hydrostatic defines as the term in which a ship or the vessel which are subjected over the water and applied the different loads on it .After applying different load the stability on the ship or vessel varies due to change in center of buoyancy and meta center.

2.1.1 Archimedes principal

The center of the gravity and the center of buoyancy force applied on the ship or the vessel that help the ship or vessel to float on the surface of the water. The gravitational force applied at the middle of the ship in downward direction and the center of the buoyancy force applied on the center of the ship in the upward direction. This is the base principal of the ship floating on the surface of the water[3].

2.2 Components of The Barge

The propulsion force which is applied on back of the ship which help of the propeller which connected with the shaft of the engine which make the ship in the movement.The back two end edge of the ship is called as the port and the star board. The front side of the ship is called as the forward side or the bow of the ship. Some part of the ship is under the water and above the water the line of the this two interface is called as water line or the design water line. The vertical part of the ship which is under the water is called drought.The port and the star board of the ship are also known as the mirror image of the ship while designing the ship only half part of hull data is considered. There are some parameters which is used while designing the ship are as under [4]:

- Block coefficient = volume displacement of the ship under water divided by the area of the barge.
- Mid ship coefficient = Mid ship section under the water divided by the area of the barge.
- Water plane coefficient = water plane area divided by the area of the barge.

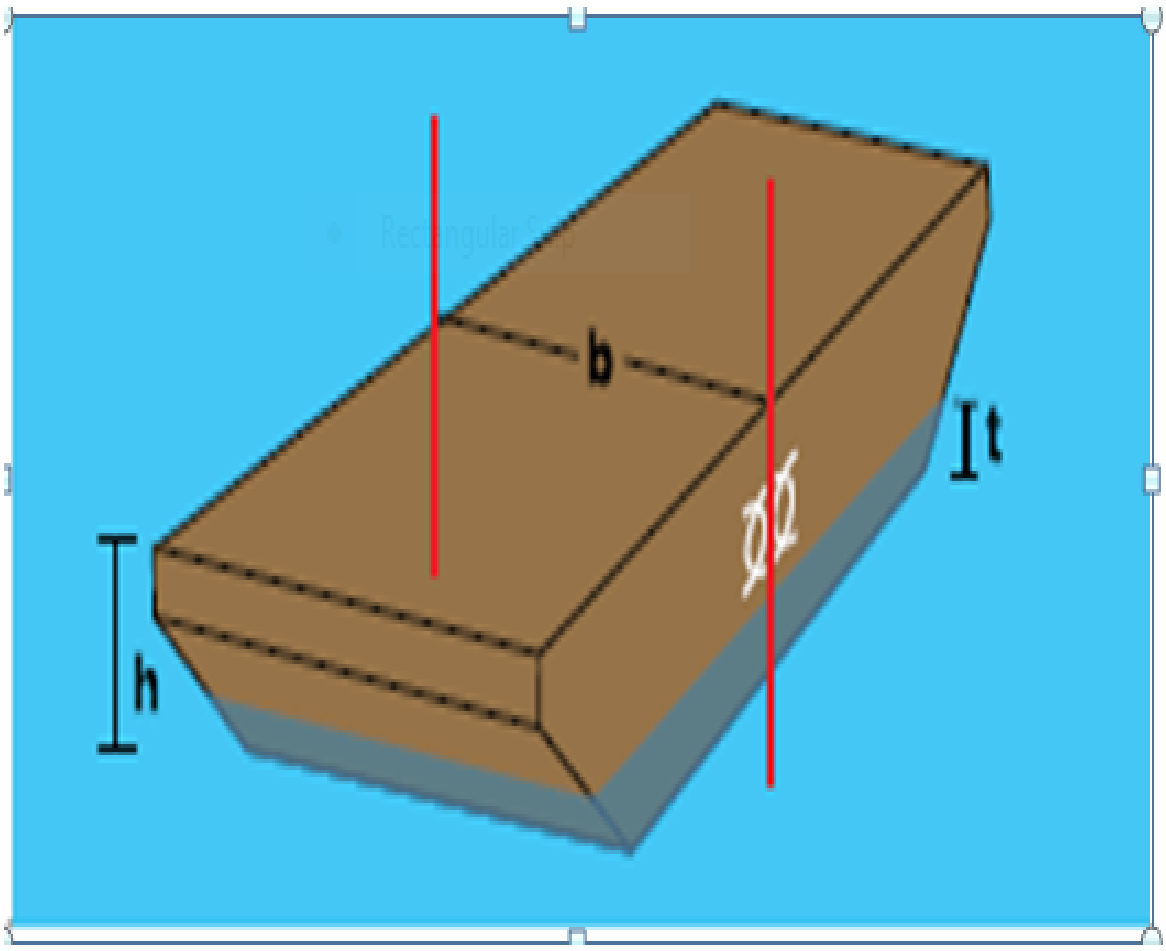

Figure 2.1: Three dimensional diagram of deck barge

2.3 Equilibrium Conditions of The Body Floating on Water

By the Newton's second law of the motions a body will said to be equilibrium when it is not accelerated or not in the motion.

Weight of the body = floating body volume of the water displaced and its weight

The stability of the ship is one of the most important part of the ship design when the centre of the gravity and the centre of the buoyancy force act at the same point then the stage of the stability will meet but if there is little bit changes in the acting point then three conditions will created to be faced us under [5]:

- At the initial stage the body will return back.
- Continuously changes in the position of the body.
- In displaced position body remains due to perturbation causes.

A vessel or ship floats freely on the surface when its specific gravity of the liquid multiples by the total volume and its weights. A body can be control draughts by adding or reducing the weights over the body when total volume of the body is greater than the specific gravity of the water. When total volume and specific gravity of the body is equals to the total weight of the body then it cannot be controlled by increasing or decreasing the depth of the drought the body will float on any measurement of the depth. when total volume and the specific gravity of the body is lesser than the total weights of the body then the body will sink and it cannot be controlled by the body.

2.4 Initial Stability of The Ship

- When the total weight of the ship and the center of the buoyancy force meet at the center point then the ship will said to be in initial stability phase.
- when the angle of heeling is small and load of the ship is fixed then the center of the gravity of the ship will also fixed .At the port point when heeling will start the center of the buoyancy force will move to the starboard hence ship will automatically comes in the initial stability phase.
- When the center of the buoyancy force and center of the weight will shift to any one side either on the port or in starboard then ship will in the condition of the unstable.

2.4.1 Meta centric Height

If the center of gravity is below the meta center then the ship is called in the stable position[6].

Meta center height = center of the buoyancy force + meta center radius – center of gravity of the floating body.

While all the design factor and calculation are done by assuming the sea surface or the water level in plane but in the actual their no static conditions we do not have control over the nature so the real conditions are very dynamic. Is there is any possible factor that the waves can affect the stability of the ship or not. The waves which comes parallel to the ship or faced in parallel positions are very dangerous in the nature .It may cause the ship in the unstable conditions and also cause disasters.

- Centrifugal force and Weight force created by the waves is perpendicular to the wave surface. In parallel waves the ship cannot be capsize and easily broken by the waves but in the head seas ship can easily capsize because waves travel along with the ships and cannot damage the ship in large scale and the healing angle will too much small. The twisting moments will also in the small range.

- Many of the accidents show that parametric roll conditions only not happened with small ships its is also happened with large dimension of the ship. A severe storm can cause twisting angle upto 35 degree to 40 degree but the material load on the large dimension ship cause too much damage and cause disaster to the ship.

The meta center varies along with intensity of the wave frequency and the stability of the ship also changes according the dynamic nature of the waves. The stability of the ship depends on the surface contact of the water line means the interface between the water and the bottom of the ship. Some time the ship positioned on the wave crest then the meta center radius decreases and the stability of the ship also changes. The ship forms and waves form some time define the amplitude of GM. One of the important factor some time hull damage may changes the center of the buoyancy force due to the collision of the ship. For prevention from the hull damages the ship designed to survive after the hull damages several tight water tanks or compartments are designed in ship. The compartments of two non adjacent flooding tanks. Lost buoyancy and gaining weight methods are two processes through which ship conditions are determined after the flood[7].

2.4.2 Effects of Load on Stability

- Duration of the loading.

- Empty tank low in hull – when the water flooded tank having low level of water according the load over the ship it may decrease the GM of the ship due to inertia of the water.

- Loading and unloading of the cargo on the ship.

- Liquid free surfaces.

- Heavy cargo on the ship- cargo height and weight may affect the stability of the ship. Because if the heeling is too much high it may affect the affect the stability of the ship.
- Maximum heeling of the ship- if the heeling angle is more than 30 degree then the ship loss its stability.
- Maximum depth of the draft.

Table 2.1: Specifications of The Barge

Length	20 meter
Wide	18 meter
Height	2.5 meter
Barge weight	90 tonnes
Load bearing capacity	300 tonnes
Flooding tanks No.	10
Working load applied	150 tonnes
Frame type	Rectangular
Material used in erection	15 mm steel plate

Chapter 3

Safe Lifting Procedure

3.1 Specification of The Segment

Table 3.1: Bridge Segment Specifications

Length	20.8 meter
Wide	3.75 meter
Height	4 Meter
Weight	130 Tonnes
Tensile strength	300 KN
Compressive strength	250 KN

3.2 Calculations For Stability of Barge

3.2.1 Effect on the depth of draft due to load

Tonnes per Centimeter Immersion – The increase in draft by one centimeter due to load.
Therefore water plane area = length at waterline × breath at water line

= 20m × 18m

= 360 m^2

Tonnes per centimeter immersion = (water plane area × density) ÷ 100

= (360m^2 × 1000 kg/m^3) ÷100

= 3.6 tonnes

The weight of 3.6 tonnes increase the one centimeter of draft due to load over it .Hence load applied over barge for segments lifting's is 150 tonnes

Therefore increase in drought = 150 tonnes ÷ 3.6 tonnes

= 41.66 centimeters.

The total increase in draft when segment loaded over barge is about 41.66 centimeters

Figure 3.1: Three dimensional diagram of deck barge

The mass of the barge:-

The mass of the floating body = mass of the water displaced

Therefore total volume of the water displaced = 20m×18m×2.5m

=900cubic meter

The mass volume if the water displaced =total volume of water displaced × density of soft water

= 900cubic metre ×1000 kg/cubic metre

= 900 tonnes

3.3 Stability

Metacentric Height (GM) = (0.5 T) + (0.0833 b^2) – H

= (0.5 × 1metre) + (0.0833 ×18×18 metre) – 2.5 metre

=24.892 metres

Combined KG = (KG1 ×W1) + (KG2×W2) ÷ (W1+W2)

= (2.5 × 90) + (6.5×130) ÷ (90 + 130)

=4.86 metres

Meta center of the barge (BM) = Moment of inertia of the barge ÷ volume of the barge

Therefore moment of inertia of the water plane (I) = (length of barge × $wide^3$)÷12

= (20 m×18^3 m) ÷12

=9720 m

Volume of the barge = length ×breath× height

= 20 m ×18 m×1 m

= 360 m^3

Therefore inertia of water plane = I÷V

= 9720 m÷360 m^3

=27 metres

Vertical Distance From The Keel To The Centre Of Buoyancy (KB)

= GM +KG –BM

=24.982 m +4.86m -27 m

=2.842 meters

In GZ curve the minimum recommended value will be 5.733 meters. The graph shows that at 30 degree t distance of 1.2 meters the ship will be in stable condition with heeling angle of 30 degree in maximum. The automatic heeling of the vessel lie between the 7 degree to 8 degree. GZ curve shows the meta center radius and twisting angle of the ship through which vessel will heel automatic but some time it should be ensure that loaded vessel may also cause the disasters when the heeling is more than 30 degree then little bit twisting moments will create large heeling and hence the hull will damage

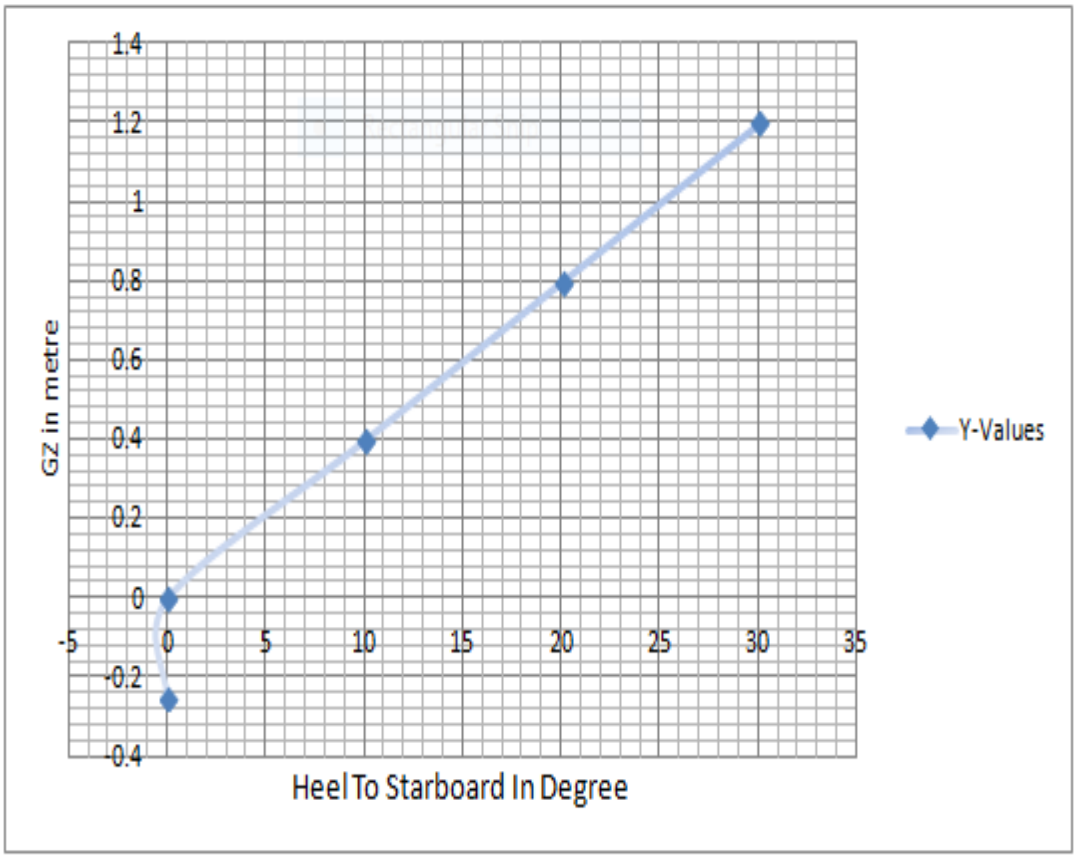

Figure 3.2: GZ curve showing the dynamic stability of the ship

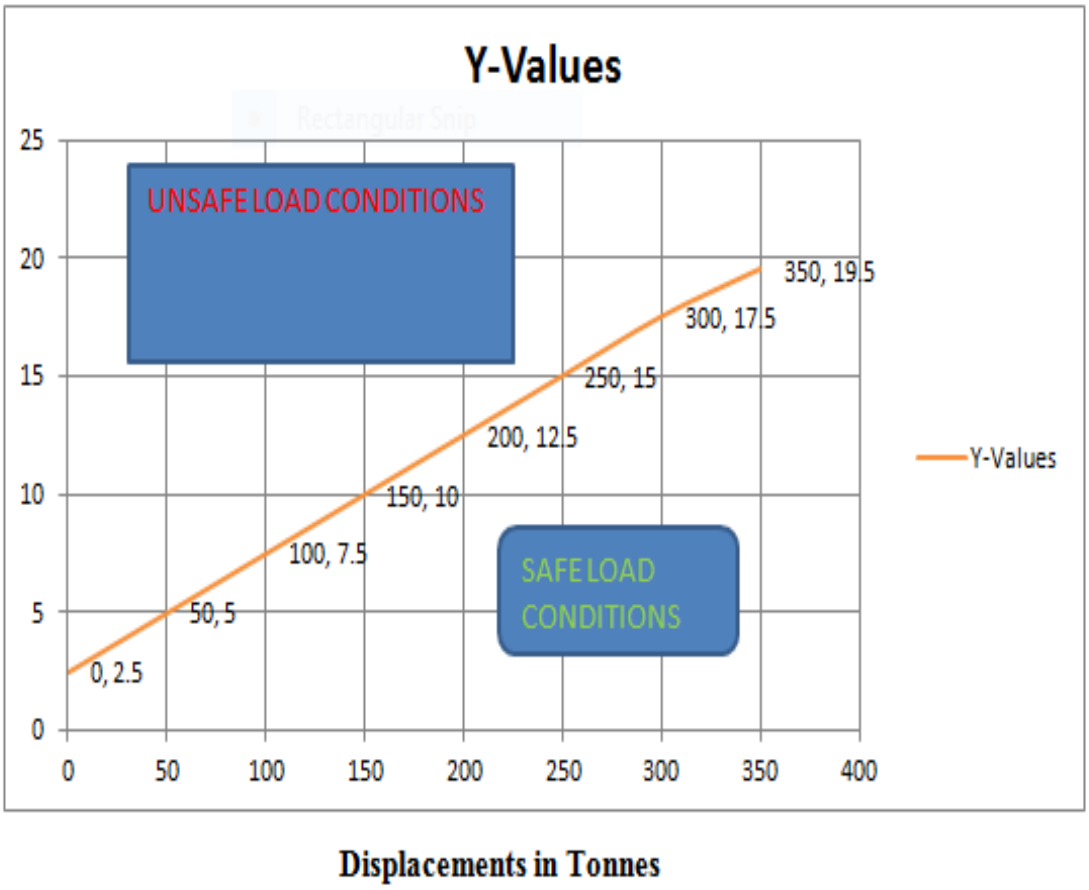

Figure 3.3: Metacentric radius and angle of heeling

While the combine load displacement is 4.86 metres hence the displacement is below the 8 meters so it is safe to lift the loads of 130 tonnes.

3.4 Strand Jacks

While in the construction industry heavy lifting is one of the most typical tasks with minimum risk frequency and hazards .In 1970 the Europeans first time used the hydraulic system for the heavy lifting .As we know that fluid is non compressible it can be maximum compressed by 10% of its actual volume . work input is equal to the work output and the same basic principal is used in the hydraulic jack systems . But the input diameter of fluid and output diameter of the fluid should be calculated so that the exact pressure should be applied according to output pressure needed for the lifting [8].

3.4.1 Specification of The Strand Jacks

Table 3.2: Specifications of the strand jacks

Jack capacity	500 tonnes
length of jack	735 mm
Gripping length	660 mm
Preferable length between two adjacent	1400 mm
outer diameter of jack	494 mm
Tensioning piston area	1045.4 cm
Blocking piston area	173.3 cm
Max. travel piston	200 mm
Blocking type	Hydraulic
Weight	480 kgs
Normal wedge set at non stressing end	mm
Normal wegde set at stressing end	3 mm
One stroke	700 mm

3.5 Strand Jacks System Installation

The following is a generic procedure were used for the system installation of the strand jacks and The power packs

- Position the power packs correctly to suit site arrangements and within the range of Hydraulic hose lengths to the jacks‟ .Ensure the power packs is level, packing underneath as necessary. Connect a suitable power supply to the power packs.
- The jacks have double acting mini jacks and require open and close hoses to each anchor Connect the extend and retract hoses to the anchors.
- Connect the mini hoses and connect a set of hoses between the remaining power packs Outlets and jacks
- After connection checks that the outlets on the pack are connected to the correct ports on the jack. All hoses are male and female to assist with correct connection as are the associated ports on the jacks and the power packs It is important that the hoses are not left coiled when hydraulic oil is to be pumped through the system
- If practically, when installation long hoses to a system couple the working pairs of hoses Together prior to connecting to the jacks and operate the power packs circuits to expel air and charge the hoses with hydraulic oil. The spool valves used on all circuits permit the oil to flow and return to tank provided the valve is operated and held for adequate time Place control cabin in a suitable position ensure the cabin level ,packing underneath if necessary Fit the electrical dressing set including sensors to jacks .Data cables and power cables should be run neatly and away from any access routes to prevent damage from external sources .They should be visually inspected regularly Ensure that a clear system of jack numbering or naming is established such that the control system operator, lift controller and site observers are using the same terminology Ensure that it is clear to the operator which jack is which. Install fixed anchor fabrications and fixed anchors Install strand in accordance with the project method statement .This may be carried out after system commissioning to facilitate opening and closing the jack anchors and cycling the jacks as required

3.6 Power Packs System Check

Ensure all ball valves on the power packs are closed

- Switch on all jacks
- If all is functioning correctly the following will be seen on the remote console. The blue selector buttons will illuminate. The digital load display readout will move to just above the red limit. The arrow load display readout will move to just above the red. Assuming all anchors are closed the mini jack’s sensor lights will all show green .Turn off all jacks. The blue lights will turn off .The power packs ball valves must still be closed Turn on the jacks

- Operate the main cylinder joysticks to extend and check that the corresponding pressure Gauge on the pack shows pressure
- Set the extend pressure relief valve must be greater than the capacity of the lifting system
- Operate the mini cylinder joystick to retract and check that the corresponding pressure Gauge on the power packs shows pressure
- The pressure shown on load 150 bar if this is not the case set the retract pressure relief Valve to the required settling
- operate the mini jacks joysticks to top and check that the corresponding pressure gauge on the power packs shows pressure
- The pressure shown should be 50 bar if this is not the case, set the mini jacks pressure Relief valve to the required settling
- Operate the mini jacks to base and check that the corresponding pressure gauge on the Power packs shows pressure .if this is not the case set the mini jack pressure relief valve.
- Repeat the above mentioned process for the safe lifting process of the segments through the strand jacks

NOTE:- During all commissioning the safety of all personnel in the vicinity of the equipments and the security of the strand must be considered .No load must be applied to the being to the Item being lifted or the temporary structures .If the jacks are the stranded the commissioning.

3.7 Narmada River

The whole segments lifting are to be done over the surface of the Narmada river so it is necessary to determine the dynamic nature of the river. The segment lifting will done in mid of the June that time minimum rainfall intensity is above the 35 mm daily. The surface modeling of the water is compulsory to make the stability of the barge and its calculations to prevent from any time of the hazards. while for segment shifting to the pier 2 barge is used so the stability of the barge and its meta center calculation is necessary which make less heeling and twisting angle will also less. Which prevent the ship and the barge from hull damage [9].

For segment shifting these arrangements are necessary needed

- Tuck boards

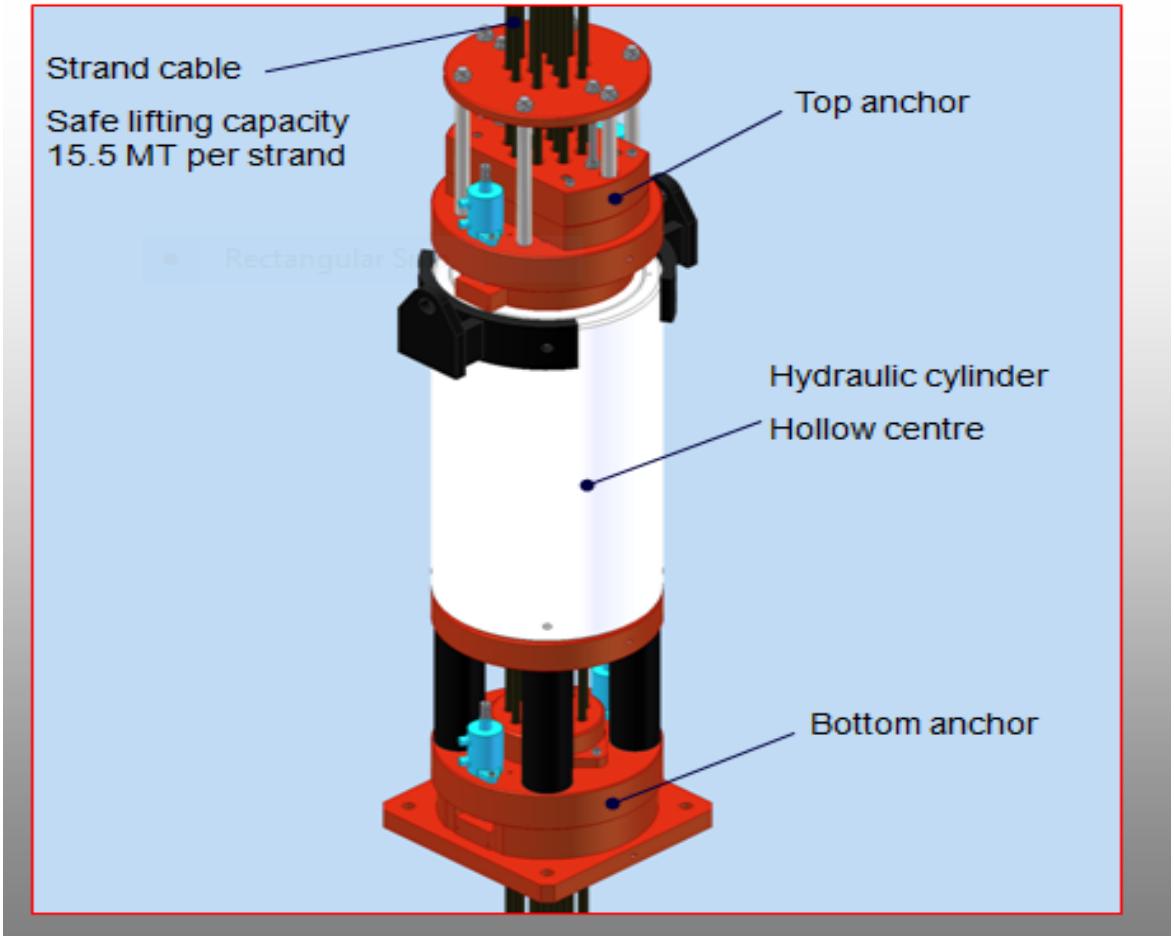

Figure 3.4: Sequences in operation of strand jacks

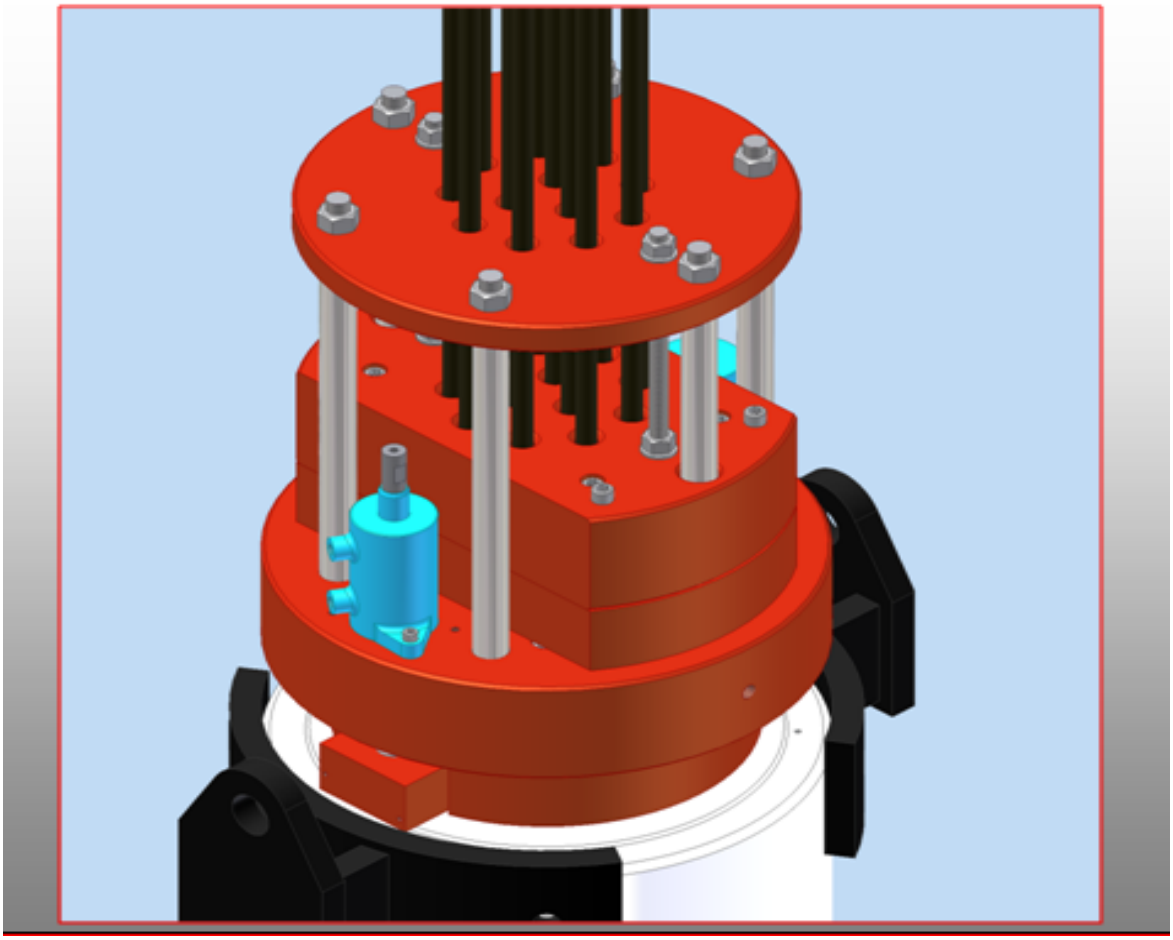

Figure 3.5: Sequences in operation of the strand cables

Table 3.3: Narmada river

Length	1312 km
Average width	1.98 km
Rainfall intensity	10000 cubic meter TO 50 000 cubic meter
Mouth of the river	Arabian sea
Average velocity	5 M/S
Discharge	101447 M^3/S
Average depth	12 meter
Mean annual rainfall	25mm
Elevation	1049 meters

- Barge
- Gantry cranes
- Liner for the positioning the gantry cranes over the barge to unload the segments
- Toe boats

As we know that waves intensity may damage the hull and stability of the ship will be lost it is necessary to make the barge movement to the direction of the waves.

3.7.1 Hydraulic Tool box software

It is free ware software available on Federal Highway Administration's (FHWA) Resource Center (RC), USA. Hydro logic and hydraulic routine computation can be done help of this software. This program help user to calculate the dynamic nature of the hydraulic and its typical calculations for the future study of fluid and for the research area .All the outputs are given in the form of the graphical representation as well as in analytical data. There are several calculators' features in this tool box software.

3.7.2 Channel analysis calculator

There are several type of the calculator featured in the this. The list of the calculators are as under

- User Defined Cross-Section
- Triangular
- Trapezoidal

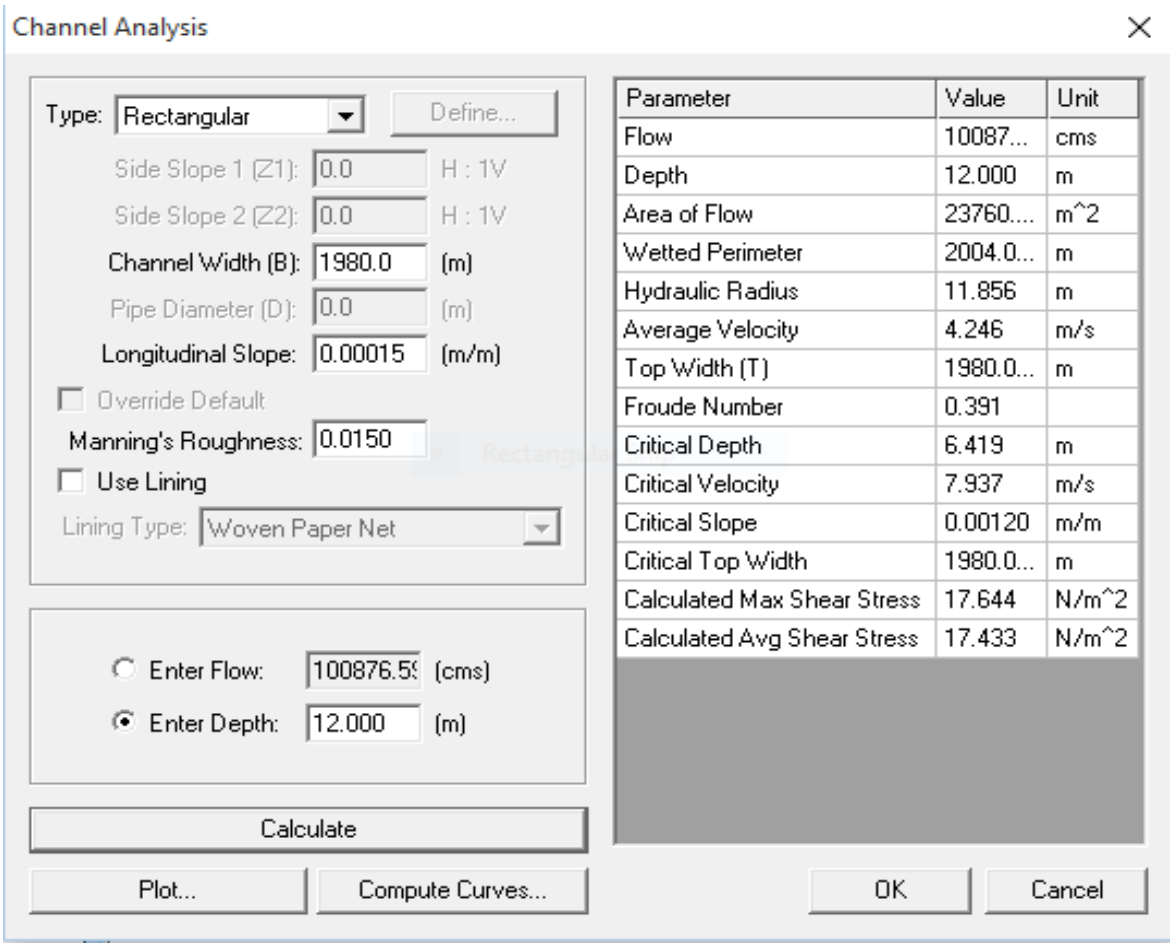

Figure 3.6: Graphical representation showing flow rate and velocity of water

- Circular

The some input data is the longitudinal slope its of the most important parameter of the flow of the liquid. The depth of the flow which helps to calculate the critical velocity, average velocity. The discharge of the flow and width of the channel which helps in the channel analysis and dynamic nature of the fluid .For the calculation of the parameters manning equation is used.

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}} \tag{3.1}$$

Where Q = Discharge flow rate of fluid

A = Area of the section

P = wetted perimter

R= Hydraulic radius

The output data is shown in the form of te graphical representaion plotted in X-Y axis .With the help of his calulator critical velocity,shear stress, slope, average velocity of the fluid is caluclated by using the manning eqution s.

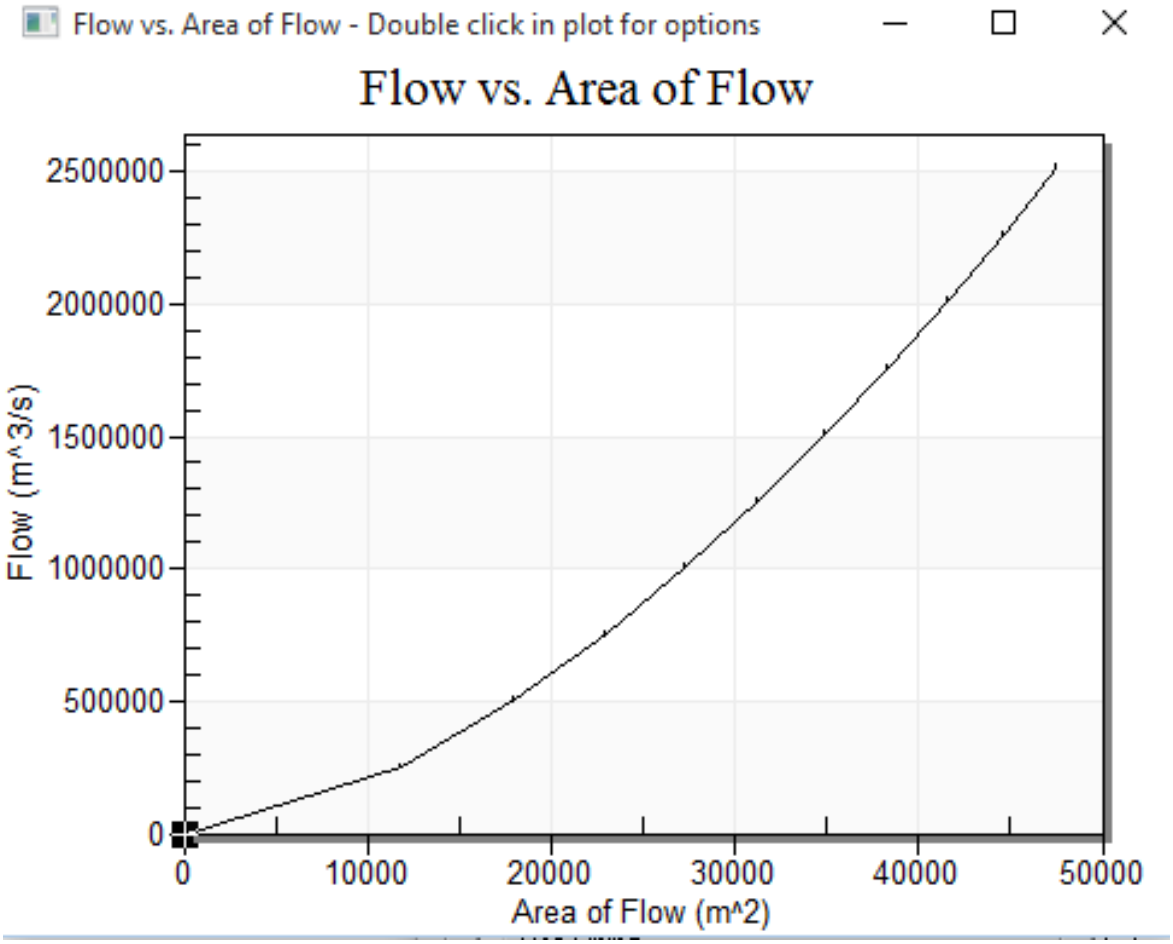

Figure 3.7: Bridge scour calculator

3.7.3 Bridge scour analysis calculator

It is used normal for the bridge foundation design and calculation of its bridging time according to the fluid nature. For the calculation some important parameters are used such as under

- Pile cap length ,width and depth
- Pier height from the bed
- Pile depth below the bed
- Dimensions of the pile
- Angle of the stack on the pile
- Elevations
- Soil nature

In this calculation Froehlich method equation is used for analysis

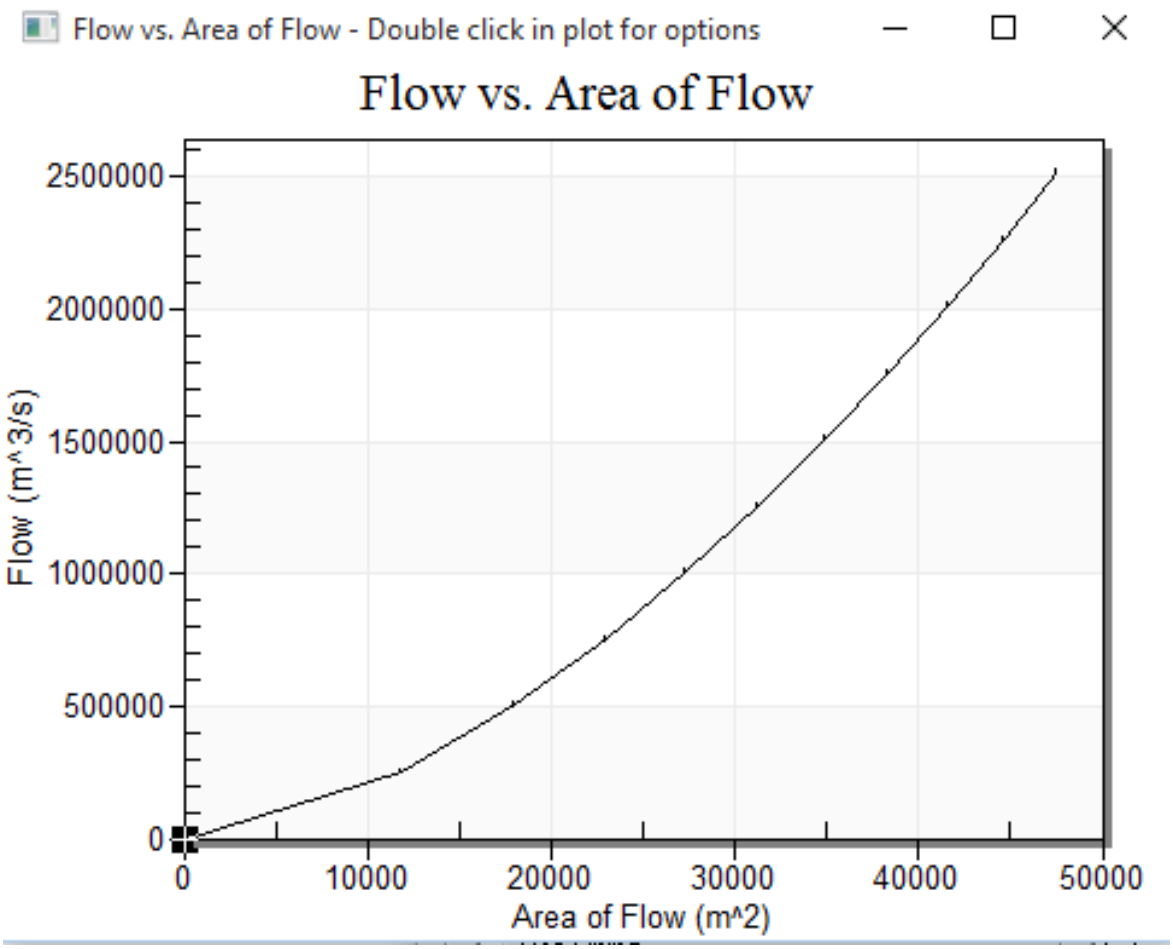

Figure 3.8: Bridge scour calculator

The universal hydrograph shows the flow rate of the discharge water from the channel of the dam during the rainfall intensity of 360mm/hours in duration of 24 hours in rainy season .The above analysis is done considering the water surface in plane nature but the practically the wave intensity affects the stability of the ship and the healing angle also depend on it. The GM also depend on the healing also due to cargo load on the ship and duration of the loading and unloading of the load .If the wind velocity is above 30m/s then it is very unsafe for the lifting of the heavy lifting .It is necessary to maintain the stability and prevent from the damage of the hull. Some time it is absorbed that when cargo shifted on the ship has maximum height and wave intensity due wing velocity of 15m/s affects the stability of the barge and creates the maximum heeling angle more than 30 degree normally for automatic angle should be between 7 degree to 8 degree. A tonne per centimeter immersion that increase or decrease the drought height also affects the stability of the ship. In the case of barge used in the lifting for segment lifting the total cargo load is about 150 tonnes it may increase the depth of the drought by 41.66 centimeters. The overall mass is about 900 tonnes on the surface of the water line of the ship. For safe lifting it is necessary to use only 50 percent efficiency of any machinery engaged in operations.

3.8 Recommendations

3.8.1 Risk assessment and hazards evaluations

As may studied state that any risk or hazards occurred due to 98% of the unsafe act and only 2% is the unsafe conditions on which we have no controls like natural disasters .If 600 of near miss is reported then we can minimize a large risk or hazards to be occur. The basic principal of the hazards evaluation is as under

- Substitution
- Elimination
- Engineering controls
- Administrative controls
- PPE'S

While in the running work it is necessary to be done regular monitoring and the evaluation of the hazards and risk analysis is to be done .The basic parameters to be considered for hazards evaluation and for the risk analysis.

Scenario based risk evaluations approaches should be done for the complete evaluation of the hazards and risk analysis .After the evaluation it can be easy to determine the judgement either the risk is too high or at medium level. If the risk is too high then there is lacuna in

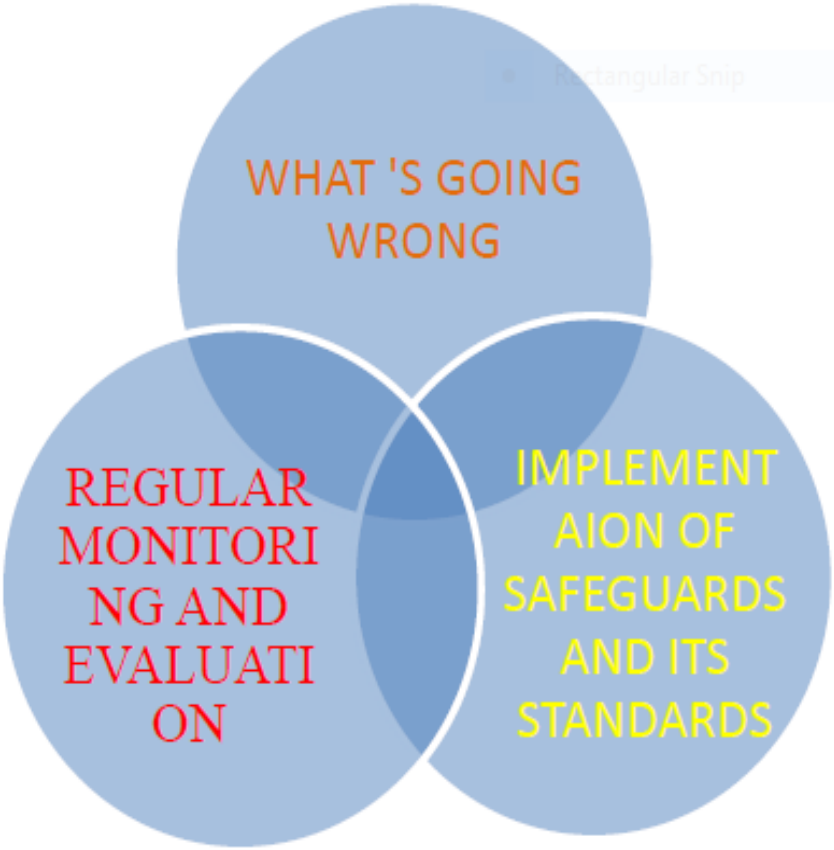

Figure 3.9: Pie chart for risk analysis

the implementation of the safe guards or its standards. At the point of the societal risk it is necessary to risk level should in ALARP.

Some time hazards evaluation used in actual practice to determine the frequency of the risk and its severity rate if occurred .Mostly HIRA is adopted in construction sector instead of HAZOP study where mechanical work is going on. The communication between the workmen's and the management and line people its is necessary in the process of the hazards evaluation and in the risk analysis .Workmen suggestion are also important factor in the minimising the risk and hazards. If unfortunately some hazards occurred the several process of investigation approached. Some of them are as under:

- FEMA (FAILURE MODE AND EFFECT ANALYSIS)
- FTA (FAULT TREE ANALYSIS).
- ETA (EVENT TREE ANALYSIS)

But it is necessary to investigation scenario based investigation and its consequences of the event for the reliable result of the incident. lost of event and its impact kept in mind while doing scenario risk evaluations Behaviour based safety is also the important factor is risk analysis. Threshold of concern if the impact is found below with respect to the evaluation of the hazards then the whole system of the work is at minimum risk level and hence it can be passed for performing the job

3.8.2 Safety standards

- Ballast or any form of fuel should be used as per specification of the engine. If it is not done it may change the trim of the ship.
- The depth of the drought should be according to weight and specific gravity of water
- It is necessary to quantify the adjacent level of flooding tanks
- Avoid the blinging of the ship to prevent from the damage
- Water tight compartments should be on the center line to maintain the ship stability
- Hull damaged should be avoided by flooding the water tanks.
- Safe working load of the vessel or ship should be calculated
- Metacentre radius should be maintained to meet the stability of the ship
- Always maintain the center of buoyancy force and centre of the gravity at the centre of the vessel or ship

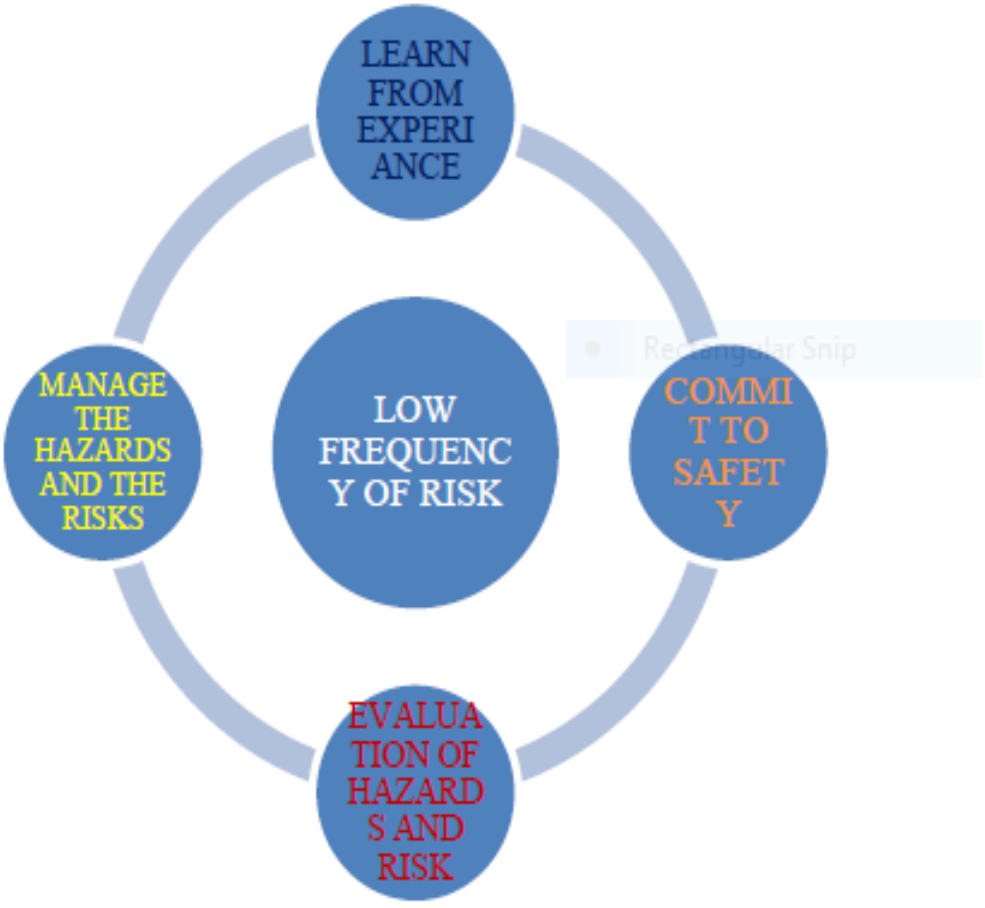

Figure 3.10: Risk and hazards evaluation by scenario based methods

- Heeling angle should be minimum if there is maximum load it is necessary to maintain load of the material shifted in the vessel.
- Minimum 18 mm in thickness of steel plate should be used in case barge where load capacity is above 300 tonnes and above.
- Always safe working method and risk assessment should be prepared in detail according the nature of work individually.
- If wind velocity is more than 30m/s it is unsafe for lifting process over the water surface.
- Calculate the safe working load and the maximum meta center with help of the GZ curve.
- 0.15 meter or less is the initial meta center height for safe working.
- The flooding angle should be in 0.03 meter in radius and if heeling angle is between 30 degree to 40 degree.
- If heeling angle is about 30 degree then the righting angle curve under area should be less than 0.05 metre and for angle of 40 degree it should be in 0.09 metre.
- The angle of heeling should not exceed more than 15 degree in case of instability of the ship it should be in between 7 degree to 8 degree in angle then it will safer to work in that condition.
- Thermal insulation either hot insulation or cold insulation should be implemented if the temperature is above 40 degree Celsius then hot insulation and if temperature is less than 40 degree Celsius then cold insulation. The direct contact of the hull should be avoided if the temperature of the body is more than 40 degree Celsius.
- If the there is unshaped or irregular shape then plastic deformation or foam insulation should be done there. Before performing the insulation it is necessary to maintain the operating temperature for hot insulation it is necessary to maintain the surface temperature at 60 degree Celsius for insulation work.
- Slabs, matters should be should if the there is composite insulation.
- Water line or design line interface between the water surfaces should be according to the design specification to maintain the stability of the ship.

3.9 Risk Assessment For Segment Lifting And Deck Erection

3.9.1 Lift co-ordinator

The Lifting Co-ordinator is to be appointed by the L&T and has overall responsibility for co-ordination and control of work activities involving lifting operations. This person is typically a Shift Supervisor or Project Engineer. The Lift Co-ordinator is someone who has the required level of competence, through practical skills and theoretical knowledge, to plan and supervise lifting operations. The Lift Co-ordinator must be able to:

a. Carry out Risk Assessments.

b. Ensuring the 3rd party certification of cranes & lifting tools & tackles. competency certificates of personnel involve in lifting operation/

c. Prepare and assess Lift Plans.

d. Conduct Toolbox Talks for SEGMENT lifting activity.

The Lift Co-ordinator is responsible for ensuring that:

a. The competence and skill mix of a team is correct.

b. Sufficient supervision of persons under training or gaining experience is given to demonstrate competence.

c. Controlling of all Lifting operation at site.

d. Does not touch the load. They must stand back from the load being handled in a prominent position where they have a good view of the lifting activities and controlling of tandem lifting (Lifting of the same single object with Two cranes)

Risk Matrix

Probability (P)	Severity (S) 1	2	3	4
1	1	2	3	4
2	2	4	6	8
3	3	6	9	12
4	4	8	12	16

Severity	Value	Probability	
Fatality	4	Very Likely	The event is almost certain to occur and has occurred repeatedly in the construction industry
Reportable Injury or Illness resulting in > 2 days off work / Permanent Total Disability / Major Pollution	3	Likely	The event will probably occur in most circumstances
Non-Reportable Lost Time Injury/ Illness resulting < 2 days off work	2	Unlikely	The event may occur only in exceptional circumstances
Injury or Illness requiring First Aid treatment. Minor Pollution	1	Very Unlikely	Very unlikely but remotely possible

Risk Rating	Risk level	Recommended actions
1 to 3	Low Risk	No additional risk control measures may be needed.
4 to 8	Medium Risk	Work can be carried out with Risk controls in place
9 to 16	High Risk	Don't start work. Risk level must be reduced to Medium / low before commencing work.

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
1A	Work At Height	Unprotected leading edges and impact of falling objects Damage due to falling objects	Fatal/serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Install edge protection (ideally guardrails at 1m with mid-rail and toe-boards). Ensure fall protection is provided for those installing guardrails • Install catch nets to protect parallel works or pedestrian routes • Install crash decks over entrances / access routes where there the risk of falling objects is significant • Install signage and illumination / lighting where necessary to highlight and warn of hazard of floor opening or leading edge • Implement permit system to open/remove edge or opening protection.	2	4	08
B		Unprotected opening / holes / shafts	Fatal/Serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Cover open holes / shafts with a crash deck or install guardrail and toe-boards around holes / slab openings with catch nets. • Install warning signs and adequate lighting arrangement for night. • When necessary to remove hole covers/protections to execute specific works, after completing the job it is mandatory install again all the covers/protections.	1	4	04
C		Lack of access or unsecured access to workplace	Fatal/Serious injury due to falls	General site workers General site staff Site visitors	4	4	16	• Provide safe means of access to every work place and inspection area. Install handrailing with toe board to protect against fall of person and materials. • Unusable / unsafe access shall be adequately protected against any willful movement of people. • Access shall be made of ladders / staircases (temp / permanent). • Use of rope ladders is discouraged. • Man baskets shall be used for any emergency cases only. • Maintain good housekeeping in the working area and keep the access free of	2	4	08

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Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
								materials or tools.			
D		Use of substandard work platforms	Fatal/serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Scrap or substandard materials shall not be used to construct temporary guardrails and or platforms • Guardrails shall be fit for purpose, sturdy enough to resist the impact of a falling / tripping man, and shall include a hand rail and mid rail. Toe boards shall be included where there is a risk of falling objects. Handrails shall be at least 1m high • Work platforms shall be bespoke platforms or constructed of rated scaffold boards. Work platforms shall include handrails, mid rails and toe-boards. Where guardrails cannot be installed due to space restrictions, fall arrest / restrain systems shall be utilized (harness / lifeline etc)	1	4	04
E		Falls of / from mobile elevating work platforms	Fatal/Serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Elevating platforms shall be maintained in accordance with the requirements set out in line with manufacturer's guidance manual. Use safety checklist to issue green card on monthly basis. • Operators shall check all equipment using daily checklist prior to use. • High level of operational discipline shall be exercised. Like firm ground, leveled equipment base, not moving the equipment while bucket in elevated position, no simultaneous operation, operator not leaving machine when people on bucket etc • Operators shall wear restrain safety lanyards in line with the requirements • Only trained, competent persons shall be permitted to operate a mobile elevating work platform (MEWP) or mast climber work platform (MCWP). This shall include all other telescopic / hydraulic man lifting devices. Operator authorization card shall be issued and displayed on equipment.	2	4	08
f	Work At Height	Falls from ladders	Fatal/serious injury due to fall	General site workers General site staff Site visitors Members of public	4	4	16	• Ladders shall be used only as access within a scaffold system where they a clamped / tied on and checked on a weekly basis as part of the scaffold inspection • Ladders / step ladders shall only be acceptable for short duration work or inspections when used as a work platform. Short durations work shall be no longer than 30 minutes. 3 point contact with ladder shall be ensured. • Ladders / step ladders shall be manufactured to recognized standard. Fabrication of ladders on site shall meet standard requirements. • Ladders / step ladders are often unstable, outriggers may be required or an additional worker must foot and steady the ladder.			08

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
								• Defective ladders must be immediately removed from service and promptly tagged not to use. • At structure of firm ladder top must be at rest position. • One meter extension of ladder should be fixed with rope at safe landing area. • The base of a ladder's side rails must rest on a firm, level foundation.			
G		Falls from Scaffolds	Fatal/serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Scaffold shall be provided with a safe means of access and / or a safe working platform. Scaffold shall be erected / dismantled in accordance with the requirements set out in L&T formwork manual and HSE Manual. • Competent / experienced scaffolders shall be engaged for erection and dismantling of scaffold. • Scaffold working platforms shall include hand rail and mid rail and where there is a danger of falling objects, toe boards shall be included • Removal work platforms and fall protection are to be used by scaffolders during the erection / dismantling process. • Install hard roof where access through scaffold is provided or public movement area. Install catch nets when scaffold is erected more than 6m height. • Keeps the scaffold working platforms clean of debris. • Alterations to scaffolds must only be carried out by persons who are competent to do so. • Follow Scaffold Tagging System.	2	4	08
H		Collapse of scaffolds	Fatal/serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Scaffold systems shall be erected in accordance with the approved scheme drawings. The manufacturer's guidelines and use of approved components and accessories shall be incorporated in scheme drawings. • Lateral support is essential when least base to height ratio is more than 2.5 or height exceeding 4m. There shall be 1 lateral tie at every 25m2 scaffold elevation area. • Scaffold shall be checked at frequent interval not later than 7 days to ensure safety condition and scaffold tag system shall be implemented through competent scaffolding foreman/Engineer. Scaffold shall be visually inspected before every	2	4	08

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Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
								use and after any adverse weather effects. • Do not overload the scaffolding with materials and keep the platforms clean of debris. • Do not secure any load to any part of scaffold. • Alterations to scaffolds must only be carried out by persons who are competent to do so. • Follow Scaffold Tagging System.			
I		Lack of, or use of, substandard fall arrest / fall restraint equipment or installation by incompetent persons	Fatal/serious injury due to falls and impact of falling objects	General site workers General site staff Site visitors Members of public	4	4	16	• Fall arrest equipment and accessories used on L&T projects shall be of approved PPE specification, make and model. No other brands/materials shall be used. • Worker shall be trained to use the fall arrest equipment in line with the requirements. • Shock / energy absorbers shall not be utilized without suitable clearance • Lifelines shall be of 8mm for single worker and 12mm steel wire rope if 2-3people anchors their harness. It shall be fitted with the correct number of clips for the intended loading. PP / Nylon rope shall not be used for static lifelines • Where necessary lifelines and anchor bolts used as lanyard anchors shall be tested prior to use.	2	4	08
J		Drop or fall of tools, machines	Fatal/serious injury due to impact of falling objects	General site workers & site staff Site visitors Members of public	4	4	16	• Secure all tools & machine while working at height using tool bags and tag lines. • Tool box, scrap box shall be used to collect /store materials and throwing of materials must never be allowed.	1	4	04
7A	Working with Electricity	Using substandard deteriorated electrical equipment & accessories	Leading to injury or fatality Electrical fire	site workers General site staff Site visitors	3	4	12	• Electrical components and accessories (distribution boards, switches, fuses, circuit breakers, cabling, sockets and splitters) used on shall be ISI marked (Indian Standard). • Electrical equipment, cables and accessories shall be periodically checked for insulation resistance, continuity to ensure fit for use. • Electrical panels shall be inspection on monthly basis and GREEN CARD system shall be followed.	1	4	04
B		Placing or using electrical installation or appliances in water/ fluid logged area	Fatality / serious injuries due to electric shock	site workers General site staff Site visitors	3	4	12	• Electrical panels shall located/routed away from water logging area. • Electrical cables shall be either Overhead or underground routed. Trailing on water logged area shall be totally prevented.	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
								• All electrical materials must be properly insulated and resistant to water.			
C		Current leakage due to insulation failure or poor jointing	Fatality / serious injuries due to electric shock	site workers General site staff Site visitors	3	4	12	• Use cables with insulation resistance of more than 2MΩ. Every electrical distribution panels, cables metal bodied equipment shall be connected to two distinct local earth. • The earth shall be constructed of good standard to achieve 2Ω resistance and it shall be checked on quarterly basis. • Install Earth Leakage Relay at main panel at 100mA and 0.5Sec setting • All connections must be routed through RCCB/RCBO with 30mA sensitivity. • ELRs / RCCBs shall be tested at least on weekly basis. • Use joint free flexible cables at site. Extensions of cables are permitted with IP44 socket & plug. • Licensed electricians shall be engaged to undertake electrical installation and maintenance works • Use standard cable jointing kit for armoured cable joints. • Protect the cable from adverse climate suitably • Always use industrial type IP44 plugs to draw electrical supply. Loose wire insertion is prohibited. • Use appropriate lugs/heat insulation tapes to connect welding cables to machine.	1	4	04
D		Contact with live parts or exposed parts	Fatality / serious injuries due to electric shock	site workers General site staff Site visitors	3	4	12	• Ensure all electrical connection meets finger-touch proof requirements. • Ensure internal cover is installed in all Electrical panels to ensure no joints are exposed.	2	4	08
E		Short circuit due to overloading of electrical installation of 1phase or whole circuit	Fatality / serious injuries due to electric shock Fire	site workers General site staff Site visitors	3	4	12	• Electrical distribution plan shall be made based on electrical load requirements. • Electrical panel and cables shall be selected based on expected load requirement. • Correct rated overload protection devices shall be installed on every distribution circuit at every stage like MCBs, HRC fuses. Rewirable fuses are prohibited from usage at construction site. • Ammeter & Volt meters shall be installed to monitor the usage. • Licensed electricians shall be engaged to undertake electrical installation and maintenance works	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
F	Working with Electricity	Working or carrying out on live electrical installation or energising installation when somebody working on it	Fatality / serious injuries due to electric shock	site workers General site staff Site visitors	3	4	12	• No work shall be carried out on live electrical installation. Electrical Lock Out and Tag Out procedure shall be implemented to work on electrical installation or electrically operated plants/machines. When more than 1 team has to work on same line, then each one should post there lock and tags. • Unauthorized entries into electrical rooms shall be prevented. Electrical rooms shall be fitted with door and locks once equipment is installed (whether live or not • Use insulation mats, insulation gloves, safety goggles while handling electrical connect. Even the tools used shall be of good insulation and ISI marked. • Licensed electricians shall be engaged to undertake electrical installation and maintenance works	1	4	04
8A		Improper installation leading to fall of electrical panels and damage to cables.	Electric shock leading to injury or fatality Electrical fire	General site workers & site staff Site visitors	3	4	12	• Electrical panels shall be made of strong supports and mounted firmly on floor. • Electrical cables shall not be subjected to pull load due to long sag/pulling. • Machine shall not be handled using cables.	1	4	04
B		Contact with existing OHT Electrical lines contact with vehicles / materials / direct contact	Electric shock leading to injury or fatality Electrical fire	General site workers General site staff Site visitors	4	4	16	• Survey the workplace for presence of overload electrical lines before commencing any activities • Demarcate the RED ZONEs in drawing and physically giving minimum 3 metres clearance or high based on voltage rating. Display warning signs & Posters • If any activity to be performed where sufficient clearance is not there, than such electrical installation shall be re-routed or shutdown until work is completed. • Overhead services present a contact risk for hydraulic arms and crane jibs. Hydraulic arms may be limited utilizing the onboard computer of modern equipment or using chains to limit reach. • The overhead line may also be protected with a steel 'goalpost' to prevent passing vehicles with elongated loads from contacting the overhead lines • Highly visible warning / hazard signage shall be posted where there is a danger for underground or overhead electrical services • Use of traffic marshals and Banksmen	1	4	04
C		Damage to trailing cables	Electric shock leading to injury or fatality Electrical fire	General site workers General site staff Site visitors	4	4	16	• Armored cabling shall be used for principle distribution where there is a risk of damage to the cable sheath • Cables crossing roads shall be armored and protected / buried • Cable hangers and cable stands shall be utilized on construction sites to elevate	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment			Control Measures	Re-assessment		
					P	S	Risk Level		P	S	Residual Risk
								trailing cables and provide additional protection from damage or water ingress			
D	Working adjacent to or near public area	Hit by moving vehicles (internal & external) and segregation of public and workplace	Personal injury / fatality Property damage	General site workers General site staff Site visitors Public	4	4	16	• Develop Traffic Risk Assessment Plan (TRAP) and identify vulnerable areas and specific measures • All personnel should wear PPE's & reflective jacket for high visibility. • Barricading should be fixed first with retro reflective's and blinker lighting as per requirement. • Sufficient Traffic Marshal shall be deployed and they shall be adequately trained. • Marshal's With red flag or Baton light , reflective jackets shall be engaged. • Adequate Road signage's shall be displayed as per IRC. • Clear Identification with signages shall be placed in case if Footpath, Bus Stop, Lamp Post, New Traffic Signal post is relocated. • Manage rash night traffic by placing ZIG ZAG barrier, placing Impact Protection Vehicles and any other best means.	1	4	04
E	Working adjacent to or near public area	Hit by vehicle while vehicle / person crossing.	Personal injury / fatality Property damage	General site workers General site staff Site visitors Public	4	4	16	• Designate road cross areas, take preference to existing zebra crossings. Avoid curve/bend areas for road crossing. • Employ traffic marshall to support people to cross roads. • Educate site team on safe behavior on road. • Where possible, install convex mirror on blind spot areas.	1	4	04
F	Working adjacent to or near public area	Falling of hand Tools or material	Personal injury / fatality Property damage	General site workers & staff Site visitors Public	4	4	16	• Safety net to be placed to prevent the small materials falling • Barricading should be provided to restrict the movement of persons • Use tools bags to carry hand tools and use tag lines to secure while using.	1	4	04
G	Working adjacent to or near public area	Unauthorized entry in work area	Personal injury / fatality	General site workers General site staff Site visitors Public	4	4	16	• Barricading should be to provide to restrict the unwanted movement of persons. Employ security where necessary to restrict unauthorized entries. • Signage's shall be placed to restrict the Unauthorized entry in work area	1	4	04
H	Working adjacent to or near public area	Noise	Personal injury/ long term health issues hearing loss	General site workers General site staff Site visitors Public	4	3	12	• Excessive noise producing machine shall provide with mufflers/silencers to suppress the noise level. • Provide ear muff if the noise exceed 75db • Plan to execute noisy activities according to the surrounding conditions. • Noise/sound level monitoring.	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
I		Dust pollution	Personal injury/ long term health issues respiratory disease	General site workers & Staff Site visitors Public	4	3	12	• Water to be sprayed before and during the operation to control the dust generation. • Use approved dust filter mask	1	4	04
								•			
E		Unsafe use of equipment by incompetent persons	Crane failure / fall of lifting materials Serious injuries to multiple persons	General site workers & site staff Site visitor Member of public	3	4	12	• Qualified / competent operator shall be engaged, P&M circular shall be adhered. Operator shall be trained by manufacturer / authorized trainers. • Unauthorized operations shall be prevented effectively. Operator authorization system shall be implemented; they shall be issued with duties / responsibility of safe operations. • A competent lifting supervisor shall be appointed to manage all lifting operations	1	4	04
F	Cranes & Lifting Cranes & Lifting	Failure of crane while lifting loads	Damage to equipment or structures due to operator error Personal injury or damage due to operator error	General site workers & site staff Site visitors	3	4	12	• Crane shall be thoroughly inspected prior engaging at site GREEN Card system shall be followed. The TPI shall be done at site and records maintained. • Hired cranes shall not be older than 15years. Own crane shall be refurbished/approved for use by central P&M. • Crane shall be checked on daily basis and recorded. Outrigger to be fully extended. • Cranes when de-rated, de-rated load chart shall be displayed to avoid miscommunication. • Crane shall not be moved while holding heavy load. • Demarcate the lift zone suitable to warn the people around. Restrict unauthorized entries. • Authorized signal man should be deployed for signaling for lifting the load.	1	4	04
G		Slings breakage/ failure	Personal injury / fatality	General site workers & site staff Site visitors	3	4	12	• Lifting equipment and accessories shall be fit for purpose, tested for its capacity, certified by competent person, carry valid color code and pre-inspected before every use. • Slings/belts shall be protected against sharp edges. • Slings shall be protected against welding current by insulating hooks / insulation packing etc. Only competent riggers / slingers shall be permitted to work on site. Evidence of valid training shall be submitted prior to appointment	1	4	04
H		Overloading of crane	Personal injury /	General site workers & site	3	4	12	• Lift plan shall be done considering all load, site and other parameters.	1	4	04

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Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Risk Level	Control Measures	Re-assessment P	Re-assessment S	Residual Risk
			fatality	staff Site visitors				• Trail lift shall be performed on empty condition to check the conditions like load capacity, obstructions etc • ASLI shall be installed on cranes, it shall cutoff crane movement when overloaded. • No lift shall be performed unless its exact weight is known. Never lift the loads from water/fluid without considering the buoyancy load. • Weight of lifting gears, spreader pieces, crane hook and fall ropes shall be considered while calculating the total weight to be lifted. • Smooth operation shall be ensured to avoid any jerk / shock loads acting on crane. When load is lifted from resting place, crane shall be allowed to relieve jerk/shock loads before raising further.			
11A		Excessive wind	Uncontrolled movement of load hitting structures & serious injury.	General site workers & site staff Site visitors	3	4	12	• Lifts shall be performed under clam weather condition only. Erection activity shall not be performed when wind speed exceeding 12m/sec. Install anemometers on crane / for site.	1	4	04
B		Collision of lifting equipment/loads	Personal injury or damage due collapse / dropped load	General site workers & site staff Site visitors	4	4	16	• A lifting plan, complete with a schedule of common lifts shall be prepared, at an early stage. • Anti-clash precautions shall be designed and implemented • Communication between riggers / signalers and crane operators shall be maintained at all time. Where possible two way radio shall be used. Where local restrictions prevent the use of two way radio, alternative arrangements shall be devised and implemented.	1	4	04
C		Unplanned Complex Lifts / Special lifts (Tandem Lifts / Lifts over 10 tonnes)	collapse of lifting equipment / failure of lifting gear personal injury or damage. Failed lift due to failure of lifting gear / accessories	General site workers & site staff Site visitors General public	4	4	16	• A specific method statement may be generated for complex or special lifts where deemed necessary by project manager • Only experienced crane operators, riggers are to be appointed for complex or special lifts • Specific method statements shall be mandatory for tandem lifts. Tandem lifts shall not be permitted without authorization of project manager • Lifting equipment and accessories shall be fit for purpose in line with the requirements set out in L&T HSE Manual for Lifting Operations	2	4	08
D		Improper set up / stabilization	Risk of tipping over Failed lift due to failure of lifting gear / accessories	General site workers & site staff Site visitors	4	4	16	• Crane shall be PLACED on firm ground of required bearing capacity as specified by competent person. For crane of 200MT and above SBC test shall be conducted.	2	4	08

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	S	Risk Level	Control Measures	Re-assessment P	S	Residual Risk
								• crane erection / dismantling shall be carried out by competent persons • A method statement shall be prepared for all tower crane erection / dismantling • Mobile cranes shall be positioned as required and outriggers fully extended. Outrigger mats to be used and an exclusion zone set up around the mobile crane • Use tag lines to hold the job, never control the loads with bare hands.			
E	Cranes & Lifting Presence of Overhead Traction line	Non-working / non maintained alarms and warning devices	Risk of tipping over Risk of dropped load	General site workers General site staff Site visitors	4	4	16	• • Alarms and warning devices on all cranes shall be maintained in working order. Cranes with damaged or nonoperational alarms / warning devices shall be removed from service • Operators shall not disable alarms for any reason and shall cease operations immediately should operating tolerances be exceeded	2	4	08
		Height works	Falls and its impact	Site workers & staff	4	4	16	• Use aviation lamps when height exceeds 30ms. • Develop precautions mentioned in work at height activities.	1	4	04
		Contact with live OHT lines	Electrocution, and failure of crane & loads	General site workers & site staff Site visitors	3	4	12	• Survey the workplace for presence of overload electrical lines before commencing any activities • Demarcate the RED ZONEs in drawing and physically giving minimum 3 metres clearance or high based on voltage rating. Display warning signs & Posters • If any activity to be performed where the clearance is insufficient, such electrical installation shall be re-routed or shutdown until work is completed. take allowance for maneuvering clearance. • Overhead services present a contact risk for hydraulic arms and crane jibs. Hydraulic arms may be limited utilizing the onboard computer of modern equipment or using chains to limit reach. • The overhead line may also be protected with a steel 'goalpost' to prevent passing vehicles with elongated loads from contacting the overhead lines • Highly visible warning / hazard signage shall be posted where there is a danger for underground or overhead electrical services. Use of traffic marshals and Banksmen • Erect goal post in vehicle movement area.	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment			Control Measures	Re-assessment		
					P	S	Risk Level		P	S	Residual Risk
		Noise	Long term ill health – hearing loss	General site workers & site staff Site visitors Neighbors	4	3	12	• Noise assessments shall be carried out across the project site focusing on frequently used plant, tools and equipment. • Acoustic enclosures to be provided in equipment to control noise level. • Workers exposed to continuous noise in excess of 85dB shall be required to wear hearing protection of at least SNR (Sound noise reduction) +30. Where national regulations or client requirements exceed this requirement, the higher requirement shall be implemented	1	4	04
		Vibration	Long term ill health – vibration white finger	General site workers & site staff Site visitors Neighbors	4	3	12	• Low vibration tools shall be specified during the procurement phase • Workers at risk of vibration white finger (e.g. those using jack hammers for long periods) shall be advised of the danger and reduce using the high vibration equipment minimized. • Workmen medical surveillance program shall be implemented to check his/her fitness to work on vibrating machines. • Where practical arrange for worker rotating.	1	4	04
	Vehicle, Tools, Plant & Equipment Working over or adjacent to water	Run over by vehicles	Fatal / Serious injuries	General site workers General site staff Site visitors	4	4	16	• Provide rest sheds for workmen to avoid them taking rest under parked vehicles. • Install Delay start in heavy vehicles and ensure the availability of chock blocks. • Ensure Reverse horns for all vehicles. • Ensure speed limit within the workplace. Display Speed limit signage.	1	4	04
		Engaging unfit drivers / extended working hours	Fatal / Serious injuries	Site workers, staff & visitors	4	4	16	• Implement IC Driving Policy effectively.	1	4	04
		Falls of person into water	Risk of drowning	General site workers & site staff Site visitors	4	3	12	• Edge protection will be provided where practicable. • Safety lines and harnesses will be worn where edge protection cannot be provided. • Where there is fast flowing water, make provision of grab lines downstream. • Gangways and areas near water will be kept clear of obstructions. • Suitable lighting (54 lux) will be provided at edges adjacent to water. • A rescue boat or other means of prompt rescue will be available when necessary. • Where there is fast flowing water, make provision of grablines downstream. • Life jacket shall be provided to all those working over the water. • Activities at edges shall not be performed on rough wind times / dark hours. • Caution board must be displayed with proper information. • Emergency Rescue team should be designated.	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
	Vehicle, Tools, Plant & Equipment	Failure plant, tools & equipment Due to poor quality / damaged	Failure during operation e.g. during cutting, grinding, drilling etc	General site workers General site staff Site visitors	4	4	16	• Only certificated of conformance and maintenance records for plant and machinery shall be reviewed at procurement stage. Risk Assessment shall be done for each plants / equipment incorporating installation & operational EHS risks. • Thoroughly check the incoming items to issue Green Card when found safe to use and recheck on monthly basis. Issue RED CARD for unfit plat / equipment; ensure it is quarantined from usage. Ensure GREEN CARD tools/ equipment are used at site • Maintain handheld / static plant and power tools with approved spare parts and fittings not alternative non approved spare parts and fittings	1	4	04
	Vehicle, Tools, Plant & Equipment Vehicle, Tools, Plant & Equipment	Entanglement with unguarded / machinery / flying of materials	Serious crush / penetration injuries	General site workers General site staff Site visitors	3	3	9	• Suitable guards shall be installed for all rotating parts of machines and protect the area where flying materials hazard like bar cutting machine. The guard shall not interfere with operation. • Critical parts guard shall be interlocked to ensure no work is executed without replacing the guard • Flying material area shall be sufficiently hazard/fenced to ensure no entry into such place.	1	3	03
		Bursting of vessels due to excessive pressure / vacuum	Serious traumatic injuries	General site workers General site staff Site visitors	3	4	12	• Pressure / vacuum vessels shall be designed/purchased conforming to standard. It shall be tested to 1.5times the working pressure before put on use and re-tested as prescribed frequencies. • Pressure gauges, safety relief valves shall be checked for its working condition on daily basis. • Vessel / pumps shall be firmly mounted on base and secured against accidental fall. • Use appropriate capacity ISI marked hoses, Use single length hoses without any joints.	1	4	04
		Operation of plant, tools & equipment by incompetent persons	Due to inexperience	General site workers & site staff Site visitors	4	4	16	• Only trained, experienced operators shall be permitted to use hand held plant & power tools • Authorisation system shall be followed for all power tools / equipment, plants. Unauthorised operation shall be totally prevented, keys shall be secured placed. • Operator shall be adequately trained to ensure they aware about the safe handling, daily pre-use checklist verification, safe operation, emergency procedures and Dos & Don'ts.	1	4	04

Sl No	Activity	Hazard	Risk Involved	People at risk	Assessment P	Assessment S	Assessment Risk Level	Control Measures	Re-assessment P	Re-assessment S	Re-assessment Residual Risk
	Working over or adjacent to water	Sinking of floating vessel/barge	Risk of drowning, serious injuries and fatal due to stuck between objects in the water	General site workers & site staff Site visitors	3	4	12	• Check the condition of vessels against corrosion, ensure sufficient anticorrosion measure taken. • Mark the Safe Working Load on every barge taking the dead weight of vessel and fill water into account. Also mark the appropriate allowable dip with respect to SWL. • A rescue boat or other means of prompt rescue shall be available when necessary. • Life jacket shall be provided to all those working over the water.	1	4	04
		Flash flood	Drowning and washing away	General site workers & site staff Site visitors	3	4	12	• Constant contact with meteorological / local department to reach flood alerts. • Erect warning signages. • Establish Emergency Siren system for quick evacuation. Conduct frequency drills.	1	4	04
		Toppling of floating vessel / barge to imbalance loading	Risk of drowning, serious injuries & fatal due to stuck between objects	General site workers & site staff Site visitors	3	4	12	• Mark the allowable level difference allowable while working on floating vessels and make such warning level more visible to operator and signaller. • Stop operations when more water oscillation / vessel dipped on one side until it is stabilized. • Activity plan should be made according to high tide /low tide.	1	4	04
		Oil spillage into water body	Water pollution	General public	3	4	12	• Never keep the drums/barrels/containers in open condition, always ensure lid on. • Employee suitable re-fueling methods to avoid oil spillages. Promptly remove the empty containers away from workplace. • Use spill trays, maintain equipment oil leak free.	1	4	04
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Chapter 4

Conclusion

Flow rate of 35000 cubic meters and wind intensity of 25 m/s affects the stability. The meta center height 2.236 meters and healing angle lies between in range of 7 degree to 8 degree makes the ship in stable position. Based on risk assessment safe working methods prepared in the detail. Elongation of strand cables by 2% of its actual volume makes the lifting operation in hazards condition. Scenario based risk analysis and hazard evaluation provide the reliable result for the analysis and it also helps to prepare the risk assessment of the individual work .Work statement of each activity should be prepared in the details and training should be conducted for each activity of the work .While in the lifting on the water surface it is necessary to understand the dynamic nature of the water surface and surface modeling of the water. For safe lifting on water ship stability is too important. Heeling angle should lies between 7 degree to 8 degree if the heeling angle is more than 30 degree the lifting is very unsafe it can damage the hull of the ship and cause disasters .Flooding tanks water level should also filled according the load on the barge. Weight of the ship is equals to the specific weight of water and its volume then ship can easily float on any depth of water.

4.1 Recommendation

Performing ever work prestart verification of the job is necessary and permit to allow the work after meeting the safety standards.It is necessary to check the some important parameter while performing the job. Safe working methods based on the risk analysis and hazards evaluation kept at the site or to the concerned personnel deputed for the job or supervision .For heaving lifting it is necessary first to the classified the lifting either it is routine lifting or critical lifting. According the nature of the lifting it is necessary the conduct the training of personnel deputed for the job.

Table 4.1: Inspection checklist before lifting

#	POINTS	OBSERVATIONS	REMARKS
1	Ensure jacks having sufficient rating to lift and sustain the loads	Yes/No	
2	Do all jacks have over travel positive stopper	Yes /No	
3	Pre inspection before lifting (destructive inspection) a. Fluid tank level b. Fluid pressure check c. Hydraulic nozzles and pipes conditions (chock age status)		
4	Anemometer reading		
5	Jacks lubrication and interval of lubrications		
6	Are jacks are inspected before and after installation by third party (competent person)	Yes/No	
7	Destructive testing fitness report (interval of 12 listings)		
8	Does flooded water tank level according to the load	Yes/No	
9	Level of the draught a. Without load b. With load		
10	Meta center radius and height		
11	High tide and low tide status		
12	Number of tuck boats engaged for shipment of segments		
13	Quick emergency team at site status		
14	Communication set ups between operator and signal men		

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Dissemination